Environment CANADA Environnement
20229931 VOL 86- ISS 5 851200
EXC # 001
TD 171.5.C3 R43
REGIONAL PROGRAM REPORT (CANADA. EN
VIRONMENTAL PROTECTION SERVICE. PAC
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AN EVALUATION OF THE MERRITT SEWAGE TREATMENT PLANT AUGUST 1985

Regional Program Report 86-05

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DECEMBER 1985

ABSTRACT

The Merritt Sewage Treatment Plant was evaluated over a 5 day-period from August 25 to August 30, 1985. The plant was last evaluated in October 1980 (EPS Regional Report 81-6).

During the last two years, the plant went through major changes in order to improve treatment performance. This study represents an assessment of the improved system in operation since the summer of 1984.

Recommendations are made to improve effluent quality and reduce its impact on the fishery resources of the Coldwater and Nicola Rivers.

RÉSUMÉ

L'usine d'épuration de Merritt fut évaluée pendant une période de 5 jours du 25 au 30 août, 1985. L'usine fut évaluée la dernière fois par le service de la protection de l'environnement (SPE) en octobre 1980 (SPE Rapport régional 81-6).

Pendant les deux dernières années, l'usine a subi de majeures modifications afin d'améliorer la performance de son traitement. Cette étude représente une évaluation de système amélioré en opération depuis l'été 1984.

Des recommendations sont faites afin d'améliorer la qualité de l'effluent et de réduire son impact sur les ressources de poissons dans les rivières Coldwater et Nicola.

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CONCLUSIONS

1. The flow equalization system represents a major improvement to the treatment.

2. The permitted final effluent total phosphorus level of 1 mg/l is not being achieved and is unlikely to be achieved with the present mode of operation.

3. BOD_5 and NFR complied at all times with the provincial permit effluent requirements for discharge to the infiltration basins (respectively 35 and 45 mg/l).

4. BOD_5 and NFR would have complied respectively 80% and 40% of the time with the provincial permit effluent requirements for a discharge to the Nicola River (respectively 15 and 10 mg/l).

5. The ferric chloride addition does not substantially reduce the phosphorus level and generates a sludge dewatering problem.

6. The secondary clarifiers are overloaded but can produce an acceptable effluent due to the coagulant addition and the control of filamentous growth by chlorination of the return sludge.

7. The chlorine contact chambers perform as additional clarifiers.

8. The infiltration basin in use during the study period appeared to drain satisfactorily.

RECOMMENDATIONS

1. Sludge wasting on a continuous basis should be practiced in order to maintain a more even mixed liquor solids level in the aeration tanks and to improve digestion in the aerobic digester.

2. Settled solids in the chlorine contact chambers should be cleaned out regularly and pumped to the aerobic digester.

3. In order to improve phosphorus removal efficiency, the plant should be tested under 3 different scenarios taken separately or in combination: 1) varying the ferric chloride addition rate, 2) moving the location of the injection to the end part of the aeration chambers and 3) using a different chemical (e.g. alum).

4. Testing using different polymers at various temperatures and pH's should be carried out in order to improve sludge dewatering and cut down on dewatered sludge trucking costs.

1 INTRODUCTION

An assessment of the operation and performance of the Merritt Sewage Treatment Plant (STP) was carried out from August 25 to 30, 1985, by the Environmental Protection Service. At the time of the study, the unchlorinated final effluent was discharging to the infiltration basins.

Twenty-four hour composite samples of the screened raw influent and final effluent were taken for 5 consecutive days. These samples were preserved and kept cool until delivery at the EPS' West Vancouver laboratory. Residues, settling and dissolved oxygen analyses on the mixed liquor as well as phosphate tests on the final effluent were performed on site.

2 PLANT DESCRIPTION

The City of Merritt STP is located on the Coldwater River upstream of the confluence with the Nicola River. The plant serves an approximate population of 6 500 and does not receive any industrial inputs. During the dry season when the Coldwater River flow is less than 5 cu.m/s, the plant effluent is discharged to ground through two alternating infiltration cells.

The plant consists of flow equalization, screening, phosphorus reduction by ferric chloride ($FeCl_3$) solution addition, biological treatment (conventional activated sludge) and clarification (Figure 1). Sewage flow averages 3 210 cu.m/day and is fed at a constant rate through the plant.

The raw sewage enters the plant in a concrete flume and is lifted by two 6 800 cu.m/day (1 250 USGPM) screw lift pumps. A control system allows a constant feed to the biological treatment by directing the peak flows to the equalization basin. At low flow periods, the influent is drawn from the equalization basin in order to keep a constant feed 24 hours a day. A Fisher Porter magnetic flow meter measures the flow directed to the aeration tank. The flow is recorded on a chart and totaled. The raw sewage then flows through a 60 cm (2 feet) wide variable speed drum screen. The screenings are carried away by a screw conveyor to a tank truck for landfilling. Ferric chloride solution (pickling liquor) is added to the screened sewage at an approximate rate of 180 ml/min. Immediately downstream of the ferric chloride injection, the secondary clarifiers sludge return joins the influent prior to flow splitting to two parallel aeration basins, approximate volume of 490 cu.m. each. The mixed liquor flows into a common flume before flow splitting to the two parallel clarifiers, approximate volume of 110 cu.m. each. In both clarifiers, a bottom scraper system pushes the settled sludge to a trough where pumps lift the sludge to either the aeration basins or the aerobic digester. All the sludge is usually directed to the aeration basins with periodic batches to the

aerobic digester when the mixed liquor solids become too high. Effluent from the clarifiers flows to a common flume prior to splitting to two parallel chlorine contact chambers. At the time of the survey, chlorination and dechlorination were not applied because the discharge was to the two alternative infiltration basins located on the west side of the Coldwater River.

Aerobic digestion is operated in a batch process. Sludge from the secondary clarifiers is periodically discharged to the aerobic digester. The digester is continually aerated. When the digester is full, aeration is stopped and the solids are allowed to settle. The supernatant is discharged to two drying/infiltration beds. The settled sludge drawn from the bottom of the digester is treated with a polymer to improve dewatering through the two parallel sludge screw presses. A conveyor carries the dewatered sludge to a tank truck for transportation to a landfill located a few kilometers out of town. The excess water is returned to the plant headworks.

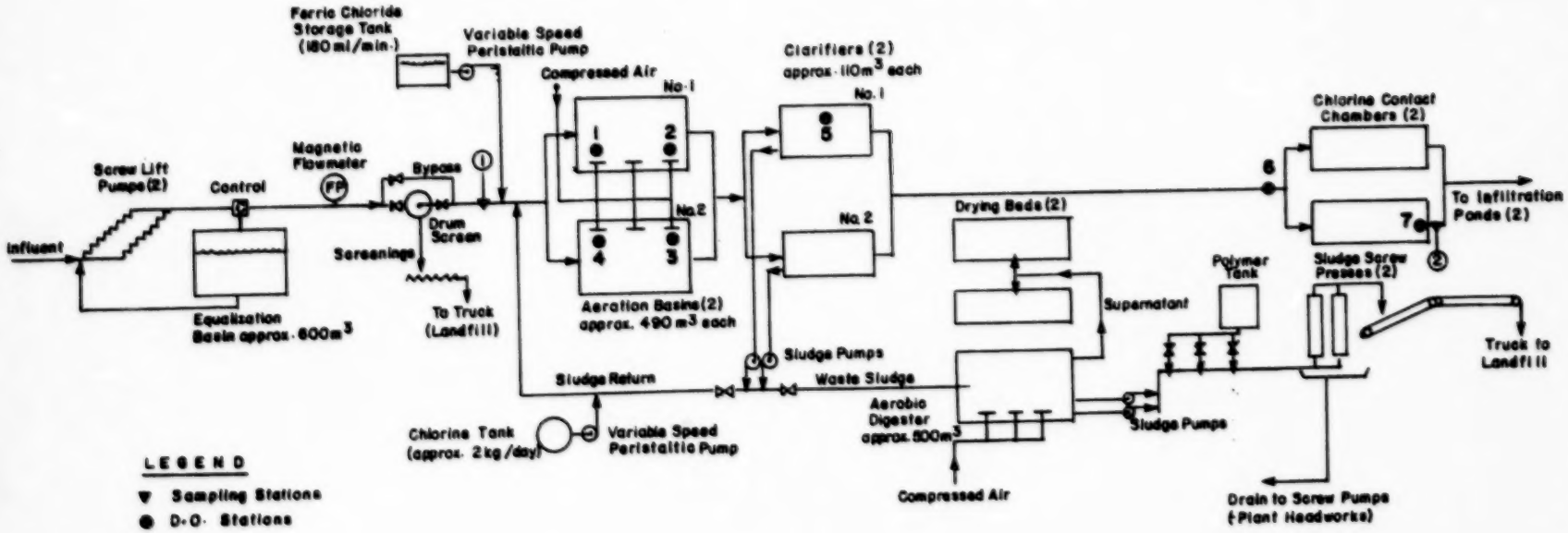

FIGURE 1 MERRITT SEWAGE TREATMENT PLANT - PROCESS FLOW DIAGRAM

3 SAMPLING PROCEDURES AND METHODS

Two automatic samplers (Sirco model MK-VS6 and Sigma model #6201) were used to collect twenty-four (24) hour composite samples of the screened raw sewage and the final effluent from August 25 to 30 (see Figure 1). Composite samples were split into sample bottles and preserved as outlined in the Environmental Laboratory Manual, EPS 1979. The samples were delivered to the EPS' West Vancouver Laboratory on September 3, 1985 for analyses.

Field tests on mixed liquor from the aeration tanks were performed to determine settling characteristics and volatile suspended solids levels. These tests were carried out according to the Environmental Laboratory Manual. Dissolved oxygen levels through the plant were determined using a Hydrolab Surveyor II model 9000. A phosphate Hach kit model PO-24 was used to test the final effluent.

4 PLANT EVALUATION

4.1 Flow Equalization

The 600 cu.m. equalization basin allows a constant feed of wastewater to the treatment plant for a large portion of the day. The operator sets the feed flow to the plant in order to have the equalization basin empty by the time the flows increase the next morning. Two automatic surface mixers keep the solids in suspension in order to avoid sedimentation and odor problems. Any overflow would be directed to the plant headworks and would trigger an alarm. The system seems to be very reliable and is a major component in the treatment efficiency.

Table 1 shows the daily influent flowrates through the plant.

TABLE 1 INFLUENT DAILY FLOWRATES

DATES	FLOWS (cu.m/d)
Aug. 25/85	3 064
Aug. 26/85	3 054
Aug. 27/85	3 280
Aug. 28/85	3 188
Aug. 29/85	3 302
Aug. 30/85	3 373

Average flow = 3 210 cu. m/day

4.2 Primary Treatment

The 60 cm (2 feet) wide variable speed rotating drum screen removes the large solids efficiently. A screw conveyor takes the screened solids to a tank truck for hauling to a landfill disposal site a few kilometres out of town. The screen location is not optimum because large solids are still allowed to enter the equalization basin. However, no problems have been encountered with this arrangement.

4.3 Phosphorus Removal

A ferric chloride ($FeCl_3$) solution, obtained from Tree Island Steel in Vancouver, is added to the screened raw wastewater at an average rate of 180 ml/min. in order to increase phosphorus removal by coagulation-sedimentation. Table 2 shows that total phosphorus reduction to the permitted value of 1.0 mg/l is not achieved.

The literature indicates that a 85% to 90% reduction in total phosphorus can be reached by using ferric chloride solution. At Merritt, an 83% reduction would be sufficient to ensure the permitted discharge of 1 mg/l.

The literature also indicates that the iron requirements for municipal wastewater are 45 to 90 mg/l as $FeCl_3$ to provide phosphorus reduction of 80 to 90 percent. The ferric chloride injection rate of 180 ml/min gives an approximate addition of 12 mg/l as $FeCl_3$. This value is about 4 times lower than the recommended addition rates. Jar tests should be carried out to determine the optimum ratio of pickling liquor/wastewater to achieve 85% to 90% total phosphorus (P) reduction.

The injection location is not optimal at the head of the aeration tanks. There are two main reasons: 1) the shearing action in the 7.3 hour retention time aeration stage breaks the floc as it forms and 2) the chemical addition can create an adverse effect on the microorganisms biological action. The addition in the last quarter of the aeration tanks would provide sufficient mixing before settling in the clarifiers and would not perturb the biological treatment. Testing should be carried out to determine optimum ferric chloride addition rate and injection location.

TABLE 2 TOTAL PHOSPHORUS REDUCTION

	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	Average
Influent, total phosphate (P)	6.08	6.28	5.59	5.65	5.76	5.87
Effluent, total phosphate (P)	2.7	2.1	1.7	1.7	2.28	2.1
Reduction (%)	55.6	66.6	69.6	69.9	60.4	64.4

4.4 Biological Treatment

Table 3 shows the biological treatment characteristics compared with typical design values. The two aeration basins provide a 7.3 hour retention time, which is in the 4 to 8 hours typical design range, for an average daily constant flow of 3 210 cu.m./day. As shown in Table 9, dissolved oxygen (D.O.) levels were low (less than 1.0 mg/l) on August 28th. However, after sludge wasting, the levels ranged from 1.2 to 2.8 mg/l on August 29th. The air compressors were working at full capacity. The warm weather experienced had a direct impact on the microorganisms activity, the oxygen uptake rate and the air compressors efficiency.

The Food/Microorganism ratio (F/M in kg BOD_5/kg MLVSS·day) is in the low range of the typical design values. This could generate a dispersed or "pin-point" floc which does not settle properly, resulting in a high Sludge Volume Index (SVI). Table 4 shows a good settling mainly due to the coagulant (ferric chloride) addition. Chlorination of the return sludge also prohibits filamentous growth which is a deterrent to good settling of activated sludge.

Sludge wasting to the aerobic digester should be done on a continuous basis in order to keep a more constant mixed liquor suspended solids in the aeration tanks. A lower solids level would allow the operator to keep a D.O. level over 1 mg/l at all times and optimize the biological activity. A higher D.O. combined with a lower solids level would minimize the filamentous growth experienced at the plant.

TABLE 3 **AERATION BASINS CHARACTERISTICS**
Number: 2
Volume: 490 cu. m. each (W = 6.7 m, L = 16.5 m, D = 4.4 m)
Flow: 1 605 cu.m/day average flow each

	TYPICAL DESIGN	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
F/M Ratio (kg BOD_5/kg MLVSS·d)	0.15-0.40	0.16	0.17	0.15	0.14	0.19
Detention Time (h.)	4-8	7.7	7.7	7.2	7.4	7.1
MLSS (mg/l)	1500-4000	2897	3213	3318	3489	2642
BOD_5 removal (%)	90-95	90	95	96	90	78

TABLE 4 MIXED LIQUOR CHARACTERISTICS

DATE	MLSS (mg/l)	MLVSS (mg/l)	SVI (ml/g)		30 MIN. SETTLING (%)	
			Tank #1	Tank #2	Tank #1	Tank #2
Aug. 25	2897	2437	62	57	20	14
Aug. 26	3213	2464	66	69	22	17
Aug. 27	3318	2316	71	77	23	18
Aug. 28	3489	2671	63	67	22	18
Aug. 29	2642	1934	64	67	17	13

SVI typical range: 35 to 150 ml/g

4.5 Secondary Clarification

Table 5 shows the secondary clarifiers characteristics. The retention time of 1.6 hours is low compared with the typical design values of 2 to 3 hours. Similarly, the hydraulic loading is high compared with the typical values. On the other hand, the addition of the ferric chloride solution increases sludge settleability.

The sludge removal system works reverse of a typical design; the sludge is drawn from the inlet end to the back end of the clarifiers. This setting could compromise the clarifiers performance because the major part of the settled sludge has to travel the whole length of the clarifiers before reaching the trough where it is pumped out; consequently, the floc could be broken due to turbulence during transportation.

TABLE 5 CLARIFIERS CHARACTERISTICS

Number: 2
Volume: 110 cu.m each (W = 2.45 m, L = 16.5 m, D = 2.75 m)

	AVERAGE FLOW (1)	TYPICAL DESIGN
Hydraulic loading ($m^3/d/m^2$)	39.7	12 to 41
Retention time (hours)	1.6	2 to 3
Length:Width ratio	6.7	3 or greater
Width:Depth ratio	0.9	1.0 to 2.25

(1) Average flow = 1 605 cu.m/d each

4.6 Chlorine Contact Chambers

Chlorination was not being performed at the time of the study because the effluent was discharging to ground. The chlorine contact chambers were used as channels to the discharge pipe leading to the infiltration basins.

Small bubbles rising to the surface indicated denitrification taking place in the chambers (confirmed by a low D.O. at Station 7 in Table 9). This also suggests the chlorination tanks act as clarifiers. Denitrification causes the solids to be re-suspended in the effluent leaving the plant and increases the non-filterable residues concentration in the final effluent. In order to avoid denitrification , the chlorine contact chambers bottoms should be cleaned of settled solids on a regular basis and pumped to the aerobic digester.

The overflow location to the infiltration basins is 0.6 m lower than the overflow location to the river.

TABLE 6 CHLORINE CONTACT CHAMBERS DIMENSIONS

	WIDTH (m)	LENGTH (m)	DEPTH (m)	VOLUME (m^3)
Discharge to river	1.22	15.4	2.5	46
Discharge to infiltration basins	1.22	15.4	1.9	36

4.7 Aerobic Sludge Digestion

The aerobic sludge digester has a volume of approximately 500 cu.m (W = 7.2 m, L = 16.5 m, D = 4.3 m). The digester is continuously aerated and receives periodically (every few days) sludge batches from the secondary clarifiers. As discussed previously, continuous sludge removal to the digester would result in a more efficient sludge digestion and a better control of the solids level in the aeration tanks.

When the digester is full, the aeration is stopped and the digested sludge is allowed to settle. Settled sludge is directed to the dewatering system and the supernatant is applied alternately to two drying/infiltration beds located next to the equalization basin.

The supernatant should be drawn from the digester before denitrification (characterised by fine bubbles rising to the surface) occurs and the solids are put back in suspension.

4.8 Sludge Dewatering

Digested sludge can be drawn at different depths from the aerobic digester. Polymer is added at various points in the pipe in order to achieve good contact and mixing. Two sludge screw presses are used to dewater the sludge. The extracted liquid is directed to the plant headworks. A conveyor carries the dewatered sludge to a tank truck to be transported to a landfill site a few kilometers out of town.

At the time of the survey, no dewatering was performed. The use of the ferric chloride solution in the plant process creates a gelatinous sludge which could not be dewatered efficiently.

Once the optimum location and rate of ferric chloride solution injection are determined, jar testing should be carried out for different polymers at various pH's and temperatures. This would indicate if reasonable dewatering is achievable with ferric chloride use in the process or whether a different chemical (e.g. alum) should be used for phosphorus removal in the plant.

5 DISCUSSION OF ANALYTICAL RESULTS

Table 8 shows the results of 24-hour composite sample taken at two points for five consecutive days (each composite sample consisted of one sample per hour). All samples were preserved and kept cool until delivery at EPS' West Vancouver Laboratory on September 3, 1985. The sample stations locations were (see Figure 1):

SAMPLE STATION	LOCATION
1	Screened raw influent prior to $FeCl_3$ addition
2	Final effluent downstream of the chlorine contact chambers

The results for BOD_5, COD and TOC are indicative of effective biodegradation through the plant. Low effluent nitrate and high ammonia levels indicate a low degree of nitrification in the treatment.

Low effluent volatile non-filterable residue indicates good biodegradation of the organic content in the non-filterable residue.

Oil and grease as well as surfactants are substantially reduced through the plant.

As discussed previously, total phosphorus was lowered from an average of 5.87 mg/l to 2.1 mg/l for an average reduction of 64.4%. This does not compare favorably with the 90% to 95% reduction normally obtainable with ferric chloride solution addition.

EPS' five consecutive 24-hour composite sampling program is different from the sampling prescribed in provincial permit PE-115 (weekly grab samples for phosphorus and monthly grab samples for suspended solids and BOD_5) but represents better the average effluent quality.

The final effluent level of compliance is shown in Table 7. The ground disposal effluent requirements for BOD_5 and NFR (35 and 45 mg/l respectively) were met at all times whereas the total phosphorus requirement was never met. Under the same circumstances for a discharge to freshwater, BOD_5 requirement (15 mg/l) would have been met 80% of the time while NFR requirement (10 mg/l) would have been met 40% of the time. BOD_5 and NFR permit requirements can be satisfied most of the time while total phosphorus permit requirements cannot be met under the process operation used at the time of the survey.

The samples were also analysed for extractable and dissolved metals. The results are presented in Table 10. The generally low values indicate an absence of industrial inputs in the sewer system.

TABLE 7 LEVEL OF COMPLIANCE WITH THE PROVINCIAL PERMIT PE-115

EFFLUENT CHARACT. (mg/l)	PERMIT REQUIREMENTS FOR DISCHARGE TO INFILTRATION BASINS	DAYS					NUMBER OF DAYS COMPLIED	PERCENT COMPLIANCE
		1	2	3	4	5		
BOD_5	35	13	7	4	11	24	5	100
NFR (TSS)	45	29	27	9	10	35	5	100
Total Phosphorus	1.0	2.7	2.1	1.7	1.7	2.28	0	0

6 COLDWATER RIVER FLOWRATE

The provincial permit PE-115 specifies that a 5 cu.m/s flow in the Coldwater River determines if the final effluent is to be discharged to the river or to the infiltration basins. EPS staff noticed that there was no rapid way for the plant operators to establish if the river flow is greater or lower than 5 cu.m/s. EPS staff contacted the Water Survey of Canada (WSC) office in Kamloops. WSC staff installed a spike indicating the water level for a 5 cu.m/s river flow. The spike was fitted with an orange flag on the left bank wall under the bridge leading to the infiltration basins.

During the critical flows, the plant operators can now establish on a daily basis when the discharge must be shifted from the river to the ground or vice versa.

TABLE 8 MERRITT STP ANALYTICAL RESULTS

DATE	AUGUST 25-26		AUGUST 26-27		AUGUST 27-28		AUGUST 28-29		AUGUST 29-30	
SAMPLE POINT	1	2	1	2	1	2	1	2	1	2
PARAMETERS										
BOD	128	13	133	7	102	4	112	11	107	24
COD	275	55	225	55	225	40	180	85	203	90
TOC	111.1	25.9	80.6	13.4	73.4	16.5	59.3	12.5	74.2	15.1
NFR	115	29	90	27	79	9	92	10	106	35
VNFR	71	< 5	42	< 5	42	< 5	58	< 5	68	17
FR	340	360	440	400	332	372	340	360	350	360
TR	455	389	530	430	410	380	430	370	460	390
NITRITE (N)	< 0.005	0.20	0.008	0.56	0.024	0.76	0.024	0.65	0.026	1.1
NITRATE (N)	< 0.005	0.27	< 0.005	1.1	0.062	1.3	0.079	1.35	0.064	3.1
AMMONIA (N)	16.1	13.5	24	12.7	18.5	12	8.8	9.9	20	9.1
ORTHO PO_4 (P)	4.5	1.7	4.8	1.6	4.0	1.4	3.9	0.81	4.0	0.59
TOTAL PO_4 (P)	6.08	2.7	6.28	2.1	5.59	1.7	5.65	1.7	5.76	2.28
OIL & GREASE	41	< 2	30	3	27	2	15	4	18	4
SURFACTANTS	1.55	0.14	2.42	0.13	1.73	0.13	1.95	0.13	2.22	0.15
CONDUCTIVITY	680	580	880	630	630	580	630	550	630	580
ALKALINITY	267	151	261	136	241	134	234	133	245	113
PH	6.8	6.7	6.9	6.7	7.0	6.8	6.8	6.8	6.8	6.7

N.B. - the station locations are shown on Figure 1.

TABLE 9 DISSOLVED OXYGEN, TEMPERATURE AND PH LEVELS

STATION NUMBER	DEPTH (m)	TEMPERATURE (° C)		PH		D.O. (mg/l)	
		Aug. 28 09:00	Aug. 29 09:00	Aug. 28 09:00	Aug. 29 09:00	Aug. 28 09:00	Aug. 29 09:00
Aeration Tank #1							
1	0	18.80	18.87	6.70	6.61	0.70	2.41
	2	18.85	18.85	6.73	6.57	0.21	1.40
	3	18.85	18.83	6.74	6.57	0.16	1.80
2	0	18.84	18.76	6.67	6.57	1.00	1.95
	2	18.86	18.76	6.69	6.57	0.24	1.20
	3	18.86	18.73	6.71	6.56	0.19	1.79
Aeration Tank #2							
1	0	18.91	18.73	6.65	6.60	0.65	2.83
	2	18.93	18.76	6.66	6.59	0.20	2.70
	3	18.93	18.74	6.69	6.60	0.16	2.30
2	0	18.93	18.70	6.69	6.61	0.51	2.34
	2	18.95	18.70	6.70	6.61	0.30	2.18
	3	18.96	18.70	6.71	6.61	0.20	2.15
Clarifier #1							
5	0	18.77	18.63	6.72	6.59	3.80	1.96
	1	18.86	18.64	6.76	6.56	3.15	0.38
	2	18.88	18.62	6.75	6.56	3.06	1.74
Chlorine Contact Chamber							
6	0	18.55		6.61		1.00	
7	0	18.50		6.95		3.60	
	0.7	18.70		6.81		3.08	
	1.4	18.80		6.48		0.49	

N.B. - the station locations are shown in Figure 1

TABLE 10 EXTRACTABLE AND DISSOLVED METAL CONCENTRATIONS

DATE	AUGUST 25-26				AUGUST 26-27			
SAMPLE	1E	1D	2E	2D	1E	2D	2E	2D
PARAMETER								
As	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	0.074	0.079	0.17	0.158	0.215	0.235	0.173	0.183
Ba	0.113	0.04	0.031	0.013	0.074	0.265	0.028	0.014
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.003	< 0.002	< 0.002
Co	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.183	< 0.005	0.045	< 0.005	0.122	< 0.005	0.04	< 0.005
Mn	0.026	0.07	0.031	0.004	0.023	0.005	0.033	0.003
Mo	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	8.77	5.46	2.86	2.37	7.03	5.68	2.46	1.97
Pb	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sn	0.02	< 0.01	0.02	< 0.01	0.02	0.02	0.02	< 0.01
Sr	0.298	0.229	0.236	0.222	0.275	0.25	0.242	0.237
Ti	< 0.002	0.009	0.003	0.011	0.006	0.003	0.002	< 0.002
V	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Zn	0.13	0.09	0.052	0.017	0.099	0.106	0.039	0.016
Al	1.24	< 0.05	0.23	< 0.05	1.21	< 0.05	0.14	< 0.05
Fe	0.325	0.049	1.23	0.028	0.343	0.173	0.951	0.015
Si	5.7	4.4	5.8	5.6	6.3	5.7	5.7	5.7
Ca	43.9	37.2	39.2	37.0	42.8	39.8	40.2	39.5
Mg	12.1	10.5	10.2	9.9	10.5	10.3	10.5	10.5
Na	33.3	34.5	40.0	38.8	67.9	69.5	46.6	47.4

E = Extractable Metals
D = Dissolved Metals

1 = Influent
2 = Final Effluent

TABLE 10 EXTRACTABLE AND DISSOLVED METAL CONCENTRATIONS

DATE	AUGUST 27-28				AUGUST 28-29			
SAMPLE	1E	1D	2E	2D	1E	2D	2E	2D
PARAMETER								
As	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	0.153	0.159	0.173	0.166	0.125	0.137	0.175	0.182
Ba	0.071	0.217	0.018	0.015	0.084	0.228	0.027	0.015
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.125	< 0.005	0.013	< 0.005	0.107	< 0.005	0.027	< 0.005
Mn	0.021	< 0.001	0.022	0.007	0.298	0.241	0.037	< 0.016
Mo	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	6.03	4.55	2.0	1.87	5.8	4.57	1.71	1.29
Pb	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sn	0.03	< 0.01	0.02	< 0.01	0.02	< 0.01	< 0.01	< 0.01
Sr	0.266	0.241	0.24	0.233	0.263	0.239	0.24	0.226
Ti	0.022	0.005	0.002	< 0.002	0.011	0.003	0.003	0.003
V	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Zn	0.095	0.118	0.028	0.021	0.103	0.115	0.038	0.019
Al	1.17	< 0.05	< 0.05	< 0.05	0.88	< 0.05	0.1	< 0.05
Fe	0.262	0.071	0.263	0.018	0.295	0.154	0.833	0.037
Si	6.3	5.5	5.6	5.6	5.7	5.3	5.7	5.6
Ca	40.7	36.9	39.1	38.1	39.9	37.1	39.1	38.1
Mg	10.3	10.0	10.3	10.1	10.3	9.9	10.2	9.9
Na	38.5	39.4	46.7	46.0	37.1	37.6	40.6	39.2

E = Extractable Metals
D = Dissolved Metals

1 = Influent
2 = Final Effluent

TABLE 10 EXTRACTABLE AND DISSOLVED METAL CONCENTRATIONS

DATE	AUGUST 27 - 28			
SAMPLE	1E	1D	2E	2D
PARAMETER				
As	< 0.05	< 0.05	< 0.05	< 0.05
B	0.18	0.226	0.164	0.166
Ba	0.072	0.524	0.038	0.017
Be	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002
Co	< 0.005	< 0.005	< 0.005	< 0.005
Cr	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.11	< 0.005	0.051	< 0.005
Mn	0.023	0.008	0.159	0.126
Mo	< 0.005	< 0.005	< 0.005	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02
P	5.96	4.7	2.02	1.0
Pb	< 0.02	< 0.02	< 0.02	< 0.02
Sb	< 0.05	< 0.05	< 0.05	< 0.05
Se	< 0.05	< 0.05	< 0.05	< 0.05
Sn	0.02	0.01	0.01	< 0.01
Sr	0.26	0.236	0.238	0.227
Ti	0.01	0.002	0.004	0.002
V	< 0.005	< 0.005	< 0.005	< 0.005
Zn	0.095	0.158	0.06	0.027
Al	0.78	< 0.05	0.24	< 0.05
Fe	0.247	0.084	2.01	0.034
Si	6.0	5.6	5.6	5.4
Ca	40.1	37.4	38.9	37.8
Mg	10.1	9.8	9.9	9.7
Na	40	44.3	40.1	39.9

E = Extractable Metals
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1 = Influent
2 = Final Effluent

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of the following persons:

P. Velt and E. Morris, Merritt STP operators, for their generous help and assistance throughout the survey.

R. Little, Waste Management Branch technician, for the additional information supplied to the EPS staff.

J. Dickey, Urban Systems Ltd. in Kamloops, for the STP guided tour and the information regarding phosphorus ground movement around the infiltration basins.

M. Ames, Water Survey of Canada, for the rapid installation of a water level guide on the Coldwater River.

G. Bradshaw, Senior Technician, and D. Walker, Project Technologist, for their assistance in the collection, preparation and handling of samples as well as for their help regarding the on-site testing.

T. Tevendale, Head, Urban Group at EPS, for the review of this report.

Environmental Protection Service Laboratory Services personnel for performing the analyses.

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NOMENCLATURE

m^2	square metre
m^3	cubic metre
cu.m	cubic metre
l	litre
ml	millilitre
USGPM	United States gallons per minute
mm	millimetre
cm	centimetre
m	metre
km	kilometre
mg	milligram
kg	kilogram
COD	Chemical oxygen demand
TOC	Total organic carbon
BOD_5	5 day biological oxygen demand
'C	degrees Celsius
D.O.	Dissolved oxygen
NFR	Non-filterable residue
TSS	Total suspended solids
VNFR	Volatile non-filterable residue
FR	Filterable residue
TR	Total residue
MLVSS	Mixed liquor volatile suspended solids
MLSS	Mised liquor suspended solids
F/M	Food/Microorganisms ratio
SVI	Sludge volume index
N	Nitrogen
P	Phosphorus
PO_4	Phosphate
STP	Sewage treatment plant
D	Depth
L	Length
W	Width
d	day
h	hour
min.	minute